Design study of OER-CC ontology

A semantic web approach to describe Open Educational Resources

Nelson Piedra, Janneth Chicaiza, Jorge López
Escuela de Ciencias de la Computación
Universidad Técnica Particular de Loja
Loja, Ecuador
nopiedra, jachicaiza, jalopez2 [@utpl.edu.ec]

Edmundo Tovar, Oscar Martínez
Universidad Politécnica de Madrid
Universidad Miguel Hernández
Madrid, España
etovar@fi.upm.es, oscar.martinez@umh.es

Abstract—**Through the application of semantic technologies to describe Open Educational Resources, any agent (human or software-based) could process and understand its contents; therefore, the agent could perform tasks autonomously or in a more effective way. In this paper, we describe the design and validation of the OER-CC ontology, which models the domain knowledge of educational resources licensed under Creative Commons Licenses. One of the most important contributions of this work is that we implement different rules and axioms to identify inconsistencies between rights provided by a licensed on an learning material and particular uses that are performed on it.**

I. Introduction

The use of social tools is potential facilitator of a change to education based on competences and centered on students. In a previous study of Open Educational Resources (OERs) [1] we described the commitment of Universidad Técnica Particular de Loja of Ecuador (UTPL), in Ecuador, to the OER promotion and its impact in society and knowledge economy through the use of Social Software. In addition to social tools, the next level of education requires the inclusion of semantic technologies to describe learning material, so, any agent (human or software-based) could process and understand its contents; therefore, the agent can perform tasks autonomously or in a way effective way (by mean of "synergy between human and machines" [2]).

In this paper, we explore the uses of semantic paradigm in an open e-learning context. Particularly we propose, *OER-CC ontology*, which models the domain knowledge of open educational resources licensed under Creative Commons Licenses. In the future, ontology could be utilized in higher education institutions (and organizations) to facilitate sharing and discovery of their digital content.

The main goals of this research to be achieved are: (i) to describe OER and CC resources using a common vocabulary that could be used by students and professors, thus, they could support their processes of referencing, discovering, repurposing or remixing material from a diversity of repositories, and (ii) to support the performance improvement of tasks for selected domains such as information retrieval using semantic techniques.

This paper is organized as followed. Section 2 describes how OER could be described successfully using semantic based techniques. Section 3 introduces the main contribution of this work, i.e., we give details about the design and successful validation of the presented ontology OER-CC. And, section 4 presents main conclusions and work in progress.

II. Using Metadata and Ontologies to describe OER

The discovery, interchange, distribution, and reuse of OER could be greatly facilitated, educational resources could be described in a standard language in a way that any agent (human or software-based) could understand and processing its content. Below, we briefly describe two of the available options to structured data:

- **Metadata**. For learning material, three of the most recognized metadata standards are: (i) IEEE LOM (Learning Object Metadata) [3] (ii) IMS Learning Resource Metadata [1] (iii) Dublin Core Metadata Initiative[2].
- **Ontologies.** We have found several works that involve the following facts (i) the development of ontologies for the specific purpose of e-learning [4], (ii) modeling of knowledge related to a specific problem [5], (iii) use of standards for describing objects and learning resources [6], [7] and (iv) description of works licensed under Creative Commons (CC).

The efforts related to the two last aspects require special mention. Fermoso et al. [6] showed the LOM2OWL ontology which structure allows describing learning objects using the IEEE LOM standard. And, in 2008, CC published the metadata standard ccREL (Creative Commons Rights Expression Language) [8]; to date ccREL metadata, as encoded using RDFa and XMP.

III. OER-CC ontology: Design and Validation

Before the development of our ontology was carried out, we studied and selected metadata standards to describe OERs CC Licenses. Thus, we chosen IEEE-LOM to describe the main concepts of OER metadata and with respect to Creative Commons Metadata, the only current standard proposed was ccREL [8].

[1] Available in ttp://www.imsglobal.org/metadata/index.html
[2] Available in http://dublincore.org/

Once we decided how to describe metadata, the development process of our OER-CC ontology was divided into three general phases: i) OER design, ii) CC design and iii) Merging of CC and OER ontologies. In addition we developed validation activities to check the consistency and taxonomy of the ontology resulting from each phase. To perform phases i) and ii), we used METHONTOLOGY [9] guidelines.

A. OER Design

The first step was to construct a concept map[3] with the most important terms of OER knowledge domain. Of all the concepts identified in the conceptualization of the ontology, two aspects were considered the most relevant: metadata and learning resource type.

IEEE-LOM organizes metadata of a learning object into nine categories [3]. After Analyzing the requirements and characteristics of OERs, we decided to create an application profile (see **Figure 1**).

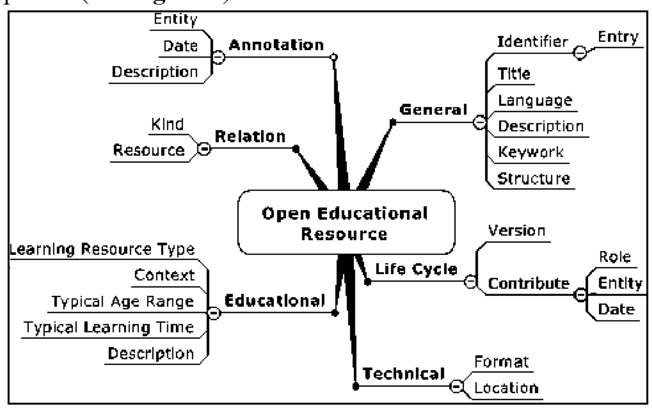

Figure 1. Application Profile based on LOM, for OER ontology

LOM proposes 58 atomic metadata, of which 22 have been included in the OER application profile. Two main reasons have guided the metadata selection, which are: (i) those that facilitate interoperability and resources recovery and (ii) those that can be obtained from repositories that store educational materials, thus minimizing the manual population of the ontology.

The **Conceptualization of OER domain** was structured according to the following groups of related metadata (i) *General Information* that included description, title and URL (ii) In respect to *Contributions metadata*, OER ontology was used to resolve issues such as the following: what were the contributions of a particular resource, who had participated and what kind of contribution had been made; who should perform the recognition of author, (iii) About *Educational Information* IEEE-LOM proposed 10 metadata to characterize the educational and pedagogical purposes of a learning resource, however, we selected 5 of them, and only the "Learning Resource Type" metadata was required, since, it is precisely the most important to remix and reuse resources and (iv) The OER structure expressed reciprocal *relations between two educational resources*; therefore, they could be used to link resources in two ways (and make logical inferences).

B. CC Design

To organize the knowledge domain of Creative Commons Licenses, we created the corresponding concept map (see **Figure 2**); however, the following issues were considered for the development of the CC ontology: types of licenses and metadata specification through *ccREL* standard.

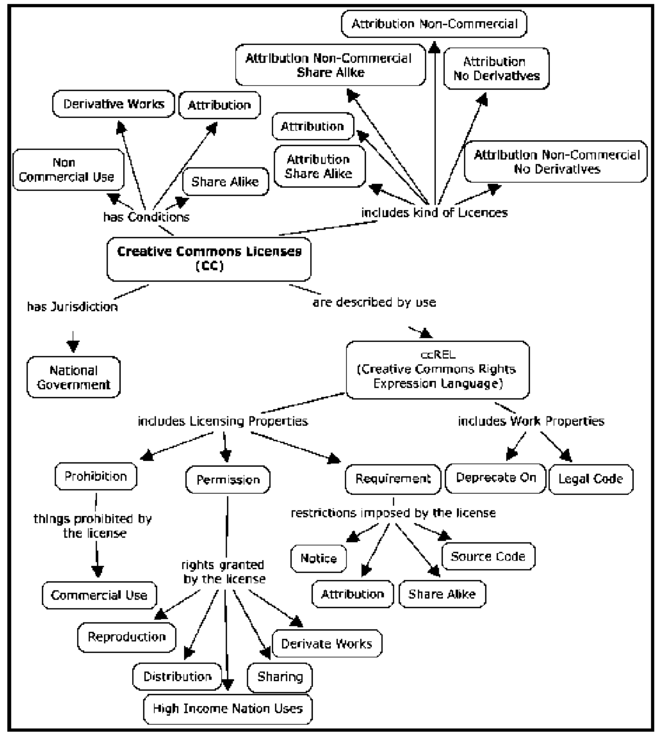

Figure 2. Creative Commons Concept Map

The **CC ontology conceptualization** included definition of the following topics: (i) License Conditions: Attribution, Share Alike, Noncommercial and No Derivative Works. These options could be selected and mixed to create different license type (ii) Each condition determines the permissions, prohibitions or requirements for a work established by its author (s) (iii) General licensing information such as: deprecated date, jurisdiction, version and legal code, and (iv) Work Properties: metadata about work is licensed under a Creative Commons License.

C. Implementation of OER & CC Ontologies

For both OER & CC ontologies, their classes, subclasses, attributes and relationships between concepts were specified in **Cmaptools Ontology Editor**[4] (COE), i.e. it was used for constructing, sharing and viewing modeled ontology based on CmapTools.

[3] CMaptool was used to represent OER and CC knowledge domains. Available in http://cmap.ihmc.us

[4] Available in http://coe.ihmc.us/groups/coe/

Once validated each model, the resulting OWL file was imported from **Protégé**[5] and from this tool the following activities were carried out: (i) Definition of annotation properties (synonym, acronym, rdfs:label and rdfs:comment) (ii) Definition of cardinality restrictions, special functions (reflexive, functional, etc.), disjoint classes and enumerations (iii) Implementation of rules and axioms using the SWRL language and (iv) Implementation of SPARQL queries to retrieve information from educational resources.

D. *Merging of OER and CC ontologies*

This work didn't include the merging of two ontologies into a single domain. Rather there are two separate namespaces, i.e. we import the CC Ontology into OER Ontology, thus may be re-used each ontology independently or we could use the integrated ontology.

One of the most important contributions of the integration of OER and CC domains in the OER-CC ontology, is that we implemented different rules and axioms to identify inconsistencies between rights provided by a licensed on an OER and particular uses that were performed on it.

E. *OER-CC ontology Validation*

During the development of each version of the OER and CC ontologies, we evaluated them independently, as the following details:

- Syntactic evaluation, by mean of Pellet 1.5.2 and RacerPro 2.0 reasoners (see **Figure 3**).
- Taxonomy evaluation, a list of errors mentioned in [10] was developed to rule out such errors in the ontologies.

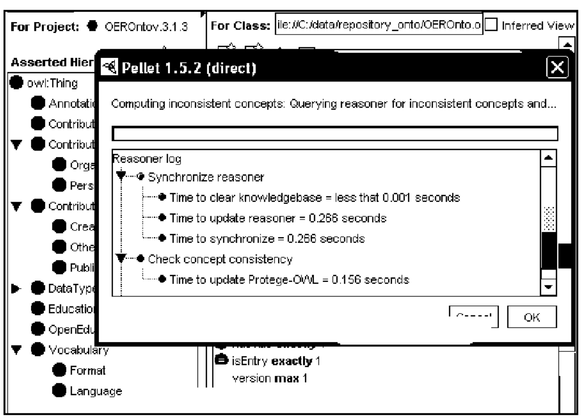

Figure 3. OER Ontology – Check Consistence

Only a few syntax errors were detected in the evaluation process; there were some incorrect settings in relations between concepts, which were corrected in later versions.

Regarding the taxonomy evaluation, no errors were identified.

CONCLUSION

As a main contribution, we have implemented OER-CC ontology to model knowledge dealing with OER and CC domains respectively. Therefore, we have been able to infer knowledge using OER-CC ontology, i.e., through instantiation and classification of educational objects respectively. Also, the ontology can be used to extract information and, geared mainly to determine its use in tasks of recovery, accessibility and OERs re-mix.

On other hand, this work has enabled us to implement ontologies from concept maps. With the support of easy-to-use graphical tools such as Cmaptools. The development of ontologies could massify, with the potential of including domain-experts. However, we conjure that although COE Cmaptools can create valid OWL ontologies, full implementation of large or complex ontologies could be confusing; therefore, we considered more appropriate to model one of the most important ontology concepts or to implement *lightweight* ontologies.

ACKNOWLEDGMENT

Support for this work was provided by a scholarship from the *Secretaría Nacional de Ciencia y Tecnología* (SENACYT) in Ecuador, and partiallly funded by eMadrid (Ref: S2009/TIC-1650) Investigación y Desarrollo de Tecnologías para el e-Learning en la Comunidad de Madrid.

REFERENCES

[1] N. Piedra, J. Chicaiza, J. López, O. Martínez & E. Tovar. Open Educational Practices and Resources Based on Social Software: UTPL experience. Proceedings of the 9th IEEE International Conference on Advanced Learning Technologies 2009 Riga, Latvia.

[2] T. Gruber, Collective knowledge systems: Where the social web. 2007. (URL link *include year)

[3] LOM Learning Object Metadata IEEE http://ltsc.ieee.org/wg12/20020612-Final-LOM-Draft.html

[4] Ghaleb, F., Daoud, S., Hasna, A., ALJa'am, J. M., El-Seoud, S. A., & El-Sofany, H., "E-Learning Model Based On Semantic Web Technology", International Journal of Computing \& Information Sciences, 2006, pp. 63-71.

[5] L. Santacruz, A. Navarro, L. Aedo& C. Delgado, "An ontology-based mechanism for assembling learning objects". IEEE Xplore , pp. 472-477, 2005

[6] A. Fermoso-Garcia, S. Alonso, & M.A. Sicilia, " Una ontolog-ía en OWL para la representación semántica de objetos de aprendizaje", 2008.

[7] Brown, C., & Thomas, B. (2007). "Metadata decision for the OER Project". The Open Polytechnic of New Zealand.

[8] H. Abelson, B. Adida, M. Linksvayer & N. Yergler. "ccREL: The Creative Commons Rights Expression Language", 2008.

[9] A. Gómez-Pérez, M. Fernández-López, and O. Corcho, "Ontological Engineering". ISBN 1-85233-551-3. Springer-Verlag, 2002. (Book style with editor)

[10] A. Gómez-Pérez, & M. C. Suárez-Figueroa, "Results of Taxonomic Evaluation of RDF(S) and DAML+OIL Ontologies using RDF(S) and DAML+OIL Validation Tools and Ontology Platforms Import Services". CEUR Workshop Proceedings, vol 87, 2003.

[5] Available in http://protege.stanford.edu